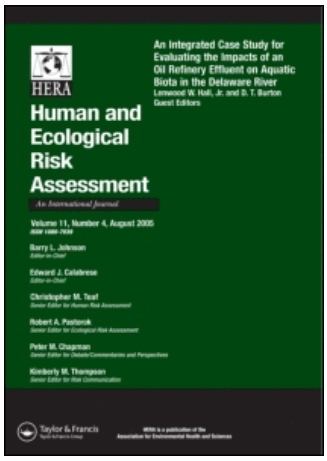

Human and Ecological Risk Assessment
An International Journal
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713400879

Comment on "An Assessment of Risk from Particulate Released from Outdoor Wood Boilers" by Brown **et al**. (2007)

To cite this Article: Long, Christopher M. and Valberg, Peter , 'Comment on "An Assessment of Risk from Particulate Released from Outdoor Wood Boilers" by Brown **et al**. (2007)', Human and Ecological Risk Assessment, 13:3, 681 - 685
To link to this article: DOI: 10.1080/10807030701341365
URL: http://dx.doi.org/10.1080/10807030701341365

Human and Ecological Risk Assessment, 13: 681–685, 2007

ISSN: 1080-7039 print / 1549-7680 online
DOI: 10.1080/10807030701341365

LETTERS TO THE EDITOR

Comment on "An Assessment of Risk from Particulate Released from Outdoor Wood Boilers" by Brown *et al.* (2007)

The increased reliance on outdoor wood-fired boilers (OWB) as an alternative heating source in residential communities has prompted recent concerns regarding potential health implications of OWB wood smoke emissions. In response to these concerns, the U.S. Environmental Protection Agency (USEPA) recently launched its voluntary partnership program for reducing OWB-related air pollution, and boiler manufacturers will soon be making available cleaner-burning OWB units that have about 70% less emissions than current models. In addition, some state and local governments are considering further regulation, including emission standards and setback requirements.

Health impact analyses are often among the tools used by policy-makers in deciding upon the appropriate level of regulation for sources of air pollution such as outdoor wood-fired boilers. A recent publication in this journal ("An Assessment of Risk from Particulate Released from Outdoor Wood Boilers" by Brown *et al.*) professes to provide a "risk assessment of outdoor wood boilers' particulate." Unfortunately, the article has a number of major errors and methodological flaws that undermine the validity of both its risk assessment findings as well as the conclusions that the authors draw from their analysis.[1] We identified errors and methodological flaws along each step of the risk assessment process, most of which contribute to an overestimation of health risks associated with OWB emissions. Due to the serious nature of these mistakes, we have strong reservations regarding any reliance on the Brown *et al.* analysis in the regulatory decision-making process.

We describe the serious methodological flaws and errors in the Brown *et al.* analysis below, but perhaps the most egregious of these flaws is the reliance on a total of only 4.3 hours of ambient air measurement data as an estimate of chronic lifetime (*e.g.*, 30-year) exposure in the cancer risk assessment. As stated on page 193 of the article, "The release by OWB of $PM_{2.5}$ as measured by Johnson (2006) will be the basis for this risk assessment." More specifically, Brown *et al.* extract two numbers, that is,

[1]Prior to its publication, we expressed our strong reservations regarding this article and enumerated on its major errors and methodological flaws to both the journal editors as well as the authors, following our review of a pre-publication copy of the manuscript. Unfortunately, with the exception of a typographical error in the Conclusions Section where cancer risks were misstated by a factor of 100, it appears that none of the other mistakes were addressed, prompting this letter to the editor.

the mean $PM_{2.5}$ measurement of 186 $\mu g/m^3$ and the 95% percentile of 665 $\mu g/m^3$, from DataRAM measurement data in Johnson (2006) to serve as exposure point concentrations (EPCs) in their cancer risk calculations. Only in a footnote (footnote #3 on page 195) is it acknowledged that the entire Johnson (2006) measurement dataset comprised a total of 4.3 hours, and nowhere do the authors clearly acknowledge the extremely limited nature of the dataset collected in the Johnson (2006) pilot study—that is, measurements made over two days at *one* residential property for one wood boiler with a nine-foot stack, at a range of distances from 50 to 150 feet from the stack. Johnson himself refers in a number of places to his measurements as a "pilot study," an "exploratory study," and a "screening level evaluation," stating on page 1166 of his article that "this pilot study was not intended to quantify 24-h or longer-term average exposures (*e.g.*, a complete heating season)." In fact, Johnson concludes with the following statement: "This screening level monitoring study recommends future research that would collect monitoring and exposure data of sufficient quality to support the evaluation of potential risks."

Furthermore, Brown *et al.* seem unaware of methodological issues raised by Johnson, and many others in prior publications (*e.g.*, Trent, 2003, 2006; Fischer and Koshland, 2006), regarding the well-known tendency of light-scattering monitors such as the DataRAM to overestimate ambient $PM_{2.5}$ concentrations, in particular for smoke aerosols. The DataRAM is a light-scattering monitor, and because light-scattering is affected by the composition and size of particles, it provides only an approximate estimate of $PM_{2.5}$ mass concentrations. As acknowledged by Johnson (2006), but not in the Brown *et al.* article, the U.S. Forest Service uses the DataRAM 4 (*i.e.*, the same model used by Johnson (2006)) to provide general trends of ambient wildfire smoke $PM_{2.5}$ concentrations, and recommends using a correction factor of 0.37 to 0.48 based on numerous tests showing that it reports high overestimations of $PM_{2.5}$ when sampling biomass combustion aerosol compared to gravimetric sampling. In other words, the U.S. Forest Service reduces DataRAM data by a factor of 2.1 to 2.7 to provide more accurate measures of ambient wildfire smoke $PM_{2.5}$ concentrations. Johnson (2006) chose not to correct his OWB field measurement data because the application of any correction factor would not have changed the approximate and qualitative nature of his study results, but he makes the observation: "Nonetheless, a more conservative assessment of these data could interpret the $PM_{2.5}$ concentrations as indicators of general trends relating to monitoring distance from the OWB, boiler operating modes, and time after fuel loading." Based on the well-recognized high bias of the DataRAM, it is clear that data correction is a necessary step prior to any quantitative use of DataRAM data, such as in a risk assessment.

One of the more serious errors in the article involves the derivation of the "conversion factor" of 6.9 that Brown *et al.* use to adjust for what they describe on page 195 as "scaling differences in burn box capacity (*i.e.*, wood stove *vs.* OWB)." As described on page 194 of the article, Brown *et al.* multiplied the PAH data they extracted from an indoor wood stove study by 6.9, claiming that "OWBs emit 6.9 times the amount of PAHs than an USEPA-Certified non-catalytic wood stove, as estimated in NYS EPB (2005)." In reality, NYS EPB (2005) made no such estimate, but they do provide a table (Table 2 on page 8 of their report) with PM and PAH emissions data in grams per hour for both OWBs and wood stoves. From this table, it is clear that Brown

et al. obtained their conversion factor of 6.9 by simply dividing the PAH emission rate given for OWBs (0.96 grams/hour) by the PAH emission rate given for USEPA-Certified non-catalytic wood stoves (0.14 grams/hour). However, this calculation is simply wrong because Brown *et al.* are doing their risk calculations on a per unit particulate matter basis, and the NYS EPB (2005) Table 2 data actually reflect PAH emission rates of 0.0134 g PAH/g PM for OWBs *versus* 0.023 g PAH/g PM for USEPA-Certified non-catalytic wood stoves. In other words, NYS EPB (2005) provides data that show a higher PAH emission rate, on a per unit particulate matter basis, for woodstoves than for OWBs. In fact, the emissions data provided in NYS EPB (2005) indicate that OWBs have 0.58 the amount of PAHs per unit particulate matter compared to non-catalytic wood stoves, meaning that the Brown *et al.* calculation error has inflated their risk assessment findings by a factor of 12.

Furthermore, despite taking the bold step of proposing their own metric for quantifying acute health risks of PM (the "Unhealthy Air Day Concept"),[2] Brown *et al.* demonstrate a limited understanding of the state of the science regarding PM health effects, and on numerous occasions they misrepresent findings from the PM health effects literature. For example, on page 193, Brown *et al.* incorrectly refer to the fact that the USEPA's Air Quality Index (AQI) "does not consider specific cardiopulmonary risks." This is simply incorrect, as the AQI for $PM_{2.5}$ is based on the $PM_{2.5}$ NAAQS, which were developed to be protective of adverse health effects, including cardiopulmonary risks specifically. Furthermore, health effect statements provided with AQI values specifically refer to possible aggravation of heart or lung disease in people with cardiopulmonary disease and older adults.

Brown *et al.* misrepresent the Dockery *et al.* (1993) study of the Harvard Six Cities long-term prospective cohort, erroneously citing it on page 193 of their article as providing support for the induction of cardiopulmonary health effects following exposures of a few hours (note that the reference on page 193 to Zanobetti *et al.* (2000) is also incorrect because this study relied on daily PM data in its analyses) and as showing 2-hour and 24-hour lags between PM increases and health outcomes on page 199. The Dockery *et al.* study was a *long-term* study that examined the association between mean pollution levels averaged over a number of years and mortality, with no references to hourly or even daily-averaged data. On page 205, Brown *et al.* refer to the association observed in the Dockery *et al.* study between $PM_{2.5}$ and lung cancer as providing support for their findings, without mention of the fact that this association was not statistically significant.

The article's citation errors also extend to literature offered in support of the health impacts of woodsmoke PM. In particular, Brown *et al.* cite epidemiological studies of ambient, all-source PM as providing evidence for the health effects of woodsmoke PM without once acknowledging that ambient PM typically consists of a

[2]Although Brown *et al.* cite two previous publications authored by Dr. Brown as supporting materials for the Unhealthy Air Day Concept, both publications are white papers rather than peer-reviewed journal articles. Furthermore, neither publication provides any discussion of the scientific basis for the "At Risk" (90 μg), "Moderate Risk" (120 μg), and "High Risk" (250 μg) dose levels that underlie their Unhealthy Air Day Concept; such a discussion is also glaringly absent from the Brown *et al.* article.

complex mixture of chemical constituents from a variety of different sources (*e.g.*, automobiles, power plants, industries, windblown dust, bioaerosols) and of varying properties. This is important because it is now widely recognized that not all PM constituents are likely of equal toxicity, with large uncertainties remaining regarding the identity of the more toxic PM constituents. In addition, in a number of places (*e.g.*, page 198), Brown *et al.* refer to a Koenig *et al.* (1993) study[3] as providing evidence for the health effects of woodsmoke PM after exposures of 2 to 4 hours or less in duration to concentrations in the range of 12 to 29 $\mu g/m^3$. However, examination of the Koenig *et al.* article does not support such a statement. Although Koenig *et al.* observe that residential wood burning was likely a major source of particulate matter measured in their study, the ambient PM measurements were not specific to woodsmoke and included contributions from other sources, for example, vehicles and industrial emissions. In addition, the Koenig *et al.* article used a light-scattering instrument and provided data in light-scattering units (*e.g.*, light-scattering coefficients) rather than $\mu g/m^3$. Furthermore, light-scattering coefficients reported in the article are for 12-hour and weekly averaged data rather than the 2 to 4 hour periods asserted by Brown *et al.*

In conclusion, based on the serious mis-steps described earlier, it is our opinion that the Brown *et al.* risk assessment is too flawed to provide credible conclusions regarding the long-term health impacts of woodsmoke from outdoor wood-fired boilers. Notwithstanding the errors in analysis, reliance on such a limited dataset to characterize lifetime exposures raises such large uncertainties that undermine the entire cancer risk assessment and any conclusions that can be drawn from it. As state and local governments consider regulations for outdoor wood-fired boilers, there is a need for the best available scientific information on potential public health risks associated with OWB emissions. The Brown *et al.* analysis clearly does not meet this need.

ACKNOWLEDGMENT

The authors declare that they provide risk assessment services to Central Boiler, Greenbush, MN, a manufacturer of outdoor wood-fired boilers.

Christopher M. Long, Sc.D.
Peter Valberg, Ph.D.

Gradient Corporation
20 University Road
Cambridge, MA 02138
E-mail: clong@gradientcorp.com

[3]Brown *et al.* incorrectly give the title of the Koenig *et al.* (1993) article as "Pulmonary function changes in children associated with particulate matter air pollution in a wood burning community" when in fact, the actual title is "Pulmonary function changes in children associated with fine particulate matter."

REFERENCES

Brown DR, Callahan BG, and Boissevain AL. 2007. An assessment of risk from particulate released from outdoor wood boilers. Hum Ecol Risk Assess 13:191–208

Dockery DW, Pope CA III, Xu X, *et al.* 1993. An association between air pollution and mortality in six U.S. cities. N Engl J Med 329:1753–9

Fischer SL and Koshland CP. 2006. Field performance of a nephelometer in rural kitchens: Effects of high humidity excursions and correlations to gravimetric analyses. J Expo Sci Environ Epidemiol. May 3 [Epub ahead of print]:1–10

Johnson PRS. 2006. In-field ambient fine particle monitoring of an outdoor wood boiler: Exposure and public health concerns. Hum Ecol Risk Assess 12:1153–70

Koenig JQ, Larson TV, Hanley QS, *et al.* 1993. Pulmonary function changes in children associated with fine particulate matter. Environ Res 63:26–38

NYS EPB (New York State Environmental Protection Bureau). 2005. Smoke Gets in Your Lungs: Outdoor Wood Boilers in New York State. New York State Office of the Attorney General, Environmental Protection Bureau, Albany, NY, USA

Trent A. 2003. Laboratory evaluation of new real-time smoke particulate monitors. Tech. Rep. 0325–2834–MTDC. US Department of Agriculture, Forest Service, Missoula Technology and Development Center, Missoula, MT, USA

Trent A. 2006. Smoke Particulate Monitors: 2006 Update. Tech. Rep. 0625–2842–MTDC. US Department of Agriculture Forest Service, Missoula Technology and Development Center, Missoula, MT, USA

Zanobetti A, Schwartz J, and Dockery DW. 2000. Airborne particles are a risk factor for hospital admissions for heart and lung disease. Environ Health Perspect 108(11):1071–7